Remarks

Claim 1 has been rewritten to incorporate claim 10, which has been canceled, to distinguish between the process invented under patent application 10/057,180 and US patent 5,730,860. Three unique conditions not covered in US 5,730,860 are now stated in claim 1. The abstract and [0011, 0013] of 10/057,180 refer to all three.

First, "bed expansion no greater than 10 percent" of 10/057,180 contrasts with 8 to 16 percent given for normal design in the example of US 5,730,860. Higher adsorbent inventories in the adsorber are required to lower the impurity level for a given feed with the same adsorbent. [0016] of 10/057,180 points out that liquid phase expansion is extremely smooth with bed expansion less than 10 percent. [0022] infers that if bed expansion is under 10 percent the beds are essentially plug flow with limited top to bottom mixing. [0053] of 10/057,180 concludes with "More than 10% bed expansion results in top to bottom circulation that is too rapid with resultant lowering of concentration differences and increase of utilities in the regeneration section 104." With an effective narrow size that prevents size segregation, a higher settled bed height is allowed with the advantages enumerated in [0055].

Second, claim1 now contains "recirculating the desired liquid condensed from the first desorption zone effluent to the latter stages of the adsorption section for certain feedstocks to increase the yield and quality of the product leaving the adsorber". [0021, 0034, and 0035] of 10/057,180 describes how with the advantages. [0071 and 0072] give further information as to how liquid recycle to the latter stages of the adsorber are obtained in the case of FCC full boiling range gasoline. No mention of liquid recycle from the first desorption zone occurs in US 5,730,860 although the same feedstock was used in its example. An octane gain of approximately 2 numbers appears possible for the full boiling FCC gasoline feedstocks over the feed with liquid recycle for 10/057,180, whatever the sulfur specification. In contrast, under current US sulfur specifications, US 5,730,860 suffers both volume loss and in octane quality because desired hydrocarbon liquids in the adsorbent pores have a higher octane number than the olefinic gasoline feedstocks [0011, 0021, 0034].

Third, claim 1 has " total reactivating gas makeup for the regenerator is reduced to a fraction of the gas entering to accomplish cool-down of the adsorbent solids leaving the final regeneration zone". Sufficient gas must enter the cool-down zone of the regenerator, whether US 5,730,860 or 10/057,180, to cool the solids leaving the final desorption zone to 105 degrees F. stated twice in body of US 5,730,860. This agrees with "less than 110 degrees F."stated in the body of 10/057,180. Makeup gas flow to ensure gas phase in the first desorption zone and provide some flow to the final desorption zone is expected to be about 3 percent of the gas volume flowing to the cool-down zone of the regenerator. US 5,730,860 has an external gas stream 144 in figure 2B of the drawings supplying all of the cooling gas necessary plus any makeup to the upper portion of the desorber vessel. Recycle gas in 10/057,180 from the final desorption zone effluent, simply treated for the removal of impurities, supplies most of the cooling gas required. This is shown in the application figure 1 drawing with [0069] stating makeup gas to the first desorption zone "at a fraction of the gas quantity that enters the cool-down zone 180." [0071] further states for all the external gas streams

supplied to the regenerator shown on figure 1 " Gas sources 204 and 184 are a comparatively small makeup gas volume that is only a fraction of that entering final desorption stage 178, generally less than .05." The final desorption zone has heated gas free from impurities passing once thru to desorb the impurities remaining on the solids leaving the first desorption zone before cooling and condensing the effluent for a more concentrated liquid impurity stream from the desorbing vessel. Thus,10/057,180 reduces external gas streams to the regenerator to that required for gas makeup only.

Some refiners expressed concern how the propane and butanes in the catalytic reformer gas supplied might affect the RVP of the gasoline treated product compared to the feed being treated. Experimental data is lacking to date to answer this question, but this concern is reduced to a fraction under plants to be designed with 10/057,180 improvements.

Claim 2 was rewritten consistent with the preferred size stated in [0016]. The advantages of a smaller particle are given in [0049,0050]. The process of manufacture limited the smallest size tested in the initial Irvad pilot plant to larger sized particles than 16 mesh. Smaller particles for a given adsorbent have a greater residence for otherwise constant conditions (given feed, same bed height, same bed expansion). Greater residence and increased external surface area increases adsorption with a higher impurity concentration on the solids leaving to enter the regenerator section. The cost of the regenerator section, the major cost [0060], is reduced with smaller particle sizes greater than 16 mesh. Tyler mesh sizes given are consistent with particle diameter ratio less than 1.6 which is necessary to avoid size segregation in liquid fluidized beds of longer lengths. Note that US 5,730,860 states in column 6, lines 55 and 56, "a closely screened, smaller size within 15 mesh" for the adsorbent which is too broad for more economical higher bed heights in the adsorber shown as desirable with the concepts of 10/057,180. The statement in [0057] benefits with particle sizes smaller than 16 mesh because less breakage occurs with a smaller particle size [0050] to reduce attrition in the regenerator. Thus, with frequency of solid regeneration reduced by the higher concentration of impurities on the adsorbent solids entering the regenerator, less adsorbent makeup is required for a given feed and product quality specification. Adsorbent makeup is a major operating cost.

Claim 5 is rewritten consistent with that given in [0028] "Because lower temperatures favor adsorption, it is preferred to maintain the liquid flow stream at a temperature less than ambient, or more preferably less than 20 degrees C." The reasons why are also stated. This is general and probably economically applicable to feedstocks other than hydrocarbons. Claim 29 is cancelled.

Claim 6 is rewritten to incorporate claim 7, which is cancelled. The claim is supported by [0074].

Claim 12 is supported by [0075, 0077].

Claim 14 is supported by [0014, 0069, 0071, 0076] as the requirements are small without the original economic need to recover the gas vent for downstream processing as with US 5,730,860.

Claim 15 is supported by the abstract and [0071] specifically mentions the equivalent .05 fraction

and [0076] states what is required by the gas makeup.

Claim 16 is supported by [0029, 0042].

Claim 17 is supported by [0063].

Claim 18 is supported by [0029, 0056]. It may be noted that claims 17 and 18 are unique to 10/057,180. US 5,730,180 does not mention either possibility.

Claim 20 is supported by [0030,0078].

Claim 21, claim 22 and claim 23 are supported by [0017]. All has been proven in a less efficient Irvad pilot plant with a batch regenerator-only how much more efficient the concepts of 10/057,180 with a continuous regenerator remain to be proven.

Claim 24, claim 25, claim 26, and claim 27 are supported by [0022, 0023,and 0047].

Claim 28 is based upon [0065]. It has been rewritten to have a specific practical limitation. The preferred .5 meter is less than 1 meter and it is known from batch regeneration that significant readsorption occurs at 1.4 meters as observed in the batch regenerator of the first Irvad pilot plant. Readsorption is reasonably expected to be less with continuous regeneration, used exclusively in 10/057,180, because the impurity in the gas leaving is less due to continuous cross flow removal as the solids increase in temperature rather than peaking in a batch regenerator. A conservative approach may be taken to reduce residence time and to further limit possible permanent carbon on the regenerated adsorbent circulated back to the adsorption section. Sufficient feed capacity is expected to be provided with this conservative approach for practical, economical construction of the regenerator.

The heat exchange for the regenerator shown for 10/057,180 is simpler than that shown for US 5,730,860 and easier to control. Although less expensive, particularly with fewer heat exchangers required, heat in the gases leaving the final desorption zone for 10/057,180 is expected to provide the final heating required for the heated gases that enter the first desorption zone with an electrical heater providing the trim heat necessary for startup. This may be expected because of the significant inlet gas temperatures differences indicated for a full boiling catalytic feedstock i.e. about 600 degrees F. versus about 400 degrees F. given in the description.

It will be noted that 4 out of 19 claims now outstanding [6, 12, 21, and 23] require a liquid hydrocarbon feed. The other claims are applicable to treating any liquid feedstock, including hydrocarbons, to remove impurities.